

from 0.2° to 5.1° over central, east, and southwest Texas, and from 0.3° to 4.7° over the coast district. The greatest excess was 5.1° at Waco. The highest was 102°, at Camp Eagle Pass on the 12th, and the lowest, 27°, at Amarillo and Mount Blanco on the 28th. The average precipitation for the State was 1.01 above the normal. There was a general excess, ranging from 0.25 to 7.77, over east Texas, the eastern portions of central and southwest Texas, the coast district, and the central portion of north Texas and the panhandle, while there was a general deficiency over the other portions of the State, ranging from 0.22 to 2.03 over the west and east portions of north Texas, the western portions of central and southwest Texas and coast district, and over west Texas, except in the vicinity of El Paso, where there was a slight excess. The greatest excess was 7.77 at Brazoria and the greatest deficiency was 2.03 in the vicinity of Brownsville. The rainfall was well distributed through the month, but was generally irregular over the State, being excessive in some localities, while there was very little in others. The greatest monthly amount, 10.23, occurred at Brazoria, while none fell at Camp Eagle Pass.—*I. M. Oline.*

Utah.—The mean temperature was 47.8°; the highest was 86°, at Cisco on the 9th, and the lowest, 7°, at Loa on the 26th. The average precipitation was 2.18; the greatest monthly amount, 3.76, occurred at Pinto, and the least, 0.28, at Park City.—*J. H. Smith.*

Virginia.—The mean temperature was 59.0°, or 1.6° above normal; the highest was 97°, at Buckingham on the 16th, and the lowest, 25°, at

Burkes Garden on the 31st. The average precipitation was 4.26, or 1.09 above normal; the greatest monthly amount, 9.64, occurred at Spottsville, and the least, 0.34, at Swords Creek.—*E. A. Evans.*

Washington.—The mean temperature was 49.8°, or 0.3° below normal; the highest was 90°, at Centerville on the 7th, and the lowest, 19°, at Centerville and Lind on the 15th. The average precipitation was 1.55, or 1.23 below normal; the greatest monthly amount, 4.55, occurred at Lapush, and the least, 0.07, at Dayton.—*G. N. Salisbury.*

West Virginia.—The mean temperature was 58.2°, or about 6.0° above normal; the highest was 95°, at Beverly on the 16th, and the lowest, 22°, at Marlinton on the 31st. The average precipitation was 0.53; the greatest monthly amount, 2.27, occurred at Harpers Ferry, and the least, 0.07, at Charleston.—*H. L. Ball.*

Wisconsin.—The mean temperature was 52.7°, or 5.1° above normal, and was the warmest October on record; the highest was 95°, at Gratiot on the 14th, and the lowest, 15°, at Wausaukee on the 17th. The average precipitation was 1.54, or 0.43 below normal; the greatest monthly amount, 3.93, occurred at Crandon, and the least, 0.27, at Viroqua.—*W. M. Wilson.*

Wyoming.—The mean temperature was 45.1°, or 0.7° below normal; the highest was 85°, at Fort Laramie on the 1st, and the lowest, 6° below zero, at Atlantic City on the 26th. The average precipitation was 1.04, or 0.28 above normal; the greatest monthly amount, 1.94, occurred at Wise, and the least, 0.21, at Lusk.—*J. B. Sloan.*

RIVER AND FLOOD SERVICE.

By PARK MORRILL, Forecast Official, in charge of River and Flood Service.

This is the time of year at which the rivers normally reach their lowest ebb. The fall has continued to the end of the month, except in the Ohio and Tennessee, which have, perhaps, taken a lasting turn toward higher water, to be soon followed by the lower Mississippi. The slight rise at New Orleans must be attributed to the effect of the Gulf tide or of wind, as the fall has been steady and pronounced at Vicksburg, and also in the Red River. It may be noted that the river stages at New Orleans during September, as well as the past month, were subject to irregular changes, which are not shown at higher stations on the Mississippi or in the Red River. The tidal effect from the Gulf is felt, in very low water, as far up the Mississippi as the mouth of the Red.

All the rivers of the Mississippi system have reached lower stages this month than are usual in their annual decline. It is, perhaps, not strange that the great flood of the spring, arising from an excessive rainfall, should be followed by a period of light rains and abnormally low water in the rivers. At all events, the Mississippi throughout its length, with the exception of the lower 100 or 200 miles, is below its normal lowest stage by 2 or 3 feet.

The highest and lowest water, mean stage, and monthly range at 117 river stations are given in the accompanying table. Hydrographs for typical points on seven principal rivers are shown on Chart V. The stations selected for charting are: Keokuk, St. Louis, Cairo, Memphis, and Vicksburg, on the Mississippi; Cincinnati, on the Ohio; Nashville, on the Cumberland; Johnsonville, on the Tennessee; Kansas City, on the Missouri; Little Rock, on the Arkansas; and Shreveport, on the Red.

The following résumé of river stages and conditions of navigation in the respective streams is compiled from reports by the officials of the Weather Bureau at various river stations and section centers:

Atlantic Coast Rivers. (Reported by A. F. Sims, Albany, N. Y.; E. R. Demain, Harrisburg, Pa.; E. A. Evans, Richmond, Va.; C. F. von Herrmann, Raleigh, N. C.; L. N. Jesunofsky, Charleston, S. C.; D. Fisher, Augusta, Ga.; and J. B. Marbury, Atlanta, Ga.)—The volume of water flowing in the Hudson River past Albany suffered a daily decrease from the 1st to the 18th, when it fell to the lowest point reached so far this season. On the 18th the Bath and Rensselaer boats struck bottom several times on their trips, and they found it necessary to seek the dock above Bath for landing, to insure safety. Except where the channels have been cut out, the water in the Albany basin was but 2 feet deep, and in many places the bottom was bare. A fall of 4 feet was experienced during the first two decades of October. The lowest

stage ever recorded at the head of tidewater was reached on Sunday, the 17th. The Troy ferryboat was obliged to stop running, and some deep-draught tugboats had to put out guy lines to prevent them from capsizing. The tug *Crandell*, with a tow of six canal boats, was stranded in the middle of the river, near the Congress street bridge, on the 17th. More than the normal amount of fog prevailed over the Hudson River during the month, the heaviest occurring on the morning of the 27th. Night boats and tows were greatly delayed, and the loss to shippers by missing trains, because of the delay of the boats, is quite an important item. The close of the month still finds a low stage of water in the Hudson.

The drought, which prevailed during the greater part of the month, affected the flow of water in all streams of the Susquehanna River system, but not so much as dry periods in some previous years, especially in the lower river. In 1895, with a rainfall of 1.63 inch at Harrisburg, the river stage averaged 0.3 foot in October, while during the past month, with a rainfall of only 1.35 inch, the average stage was 0.9 foot. The river averaged much lower, however, than during the same period last year, but the rainfall was less, averaging only about 36 per cent of the amount that fell during October, 1896. Seventeen reporting stations gave an average rainfall of 3.70 inches in October, 1896, while for October, 1897, the average for the same number of stations was 1.35 inch. The average river gauge readings of 16 stations in October, 1896, was 2.5 feet, and in 1897 less than 0.2 foot. At Renovo, Cameron, Cedar Run, Sinnemahoning, and Wilkesbarre, the water was at or below zero of the gauges during the whole month. At Lockhaven the river fell to zero on the 5th, and at East Bloomsburg it reached zero on the 9th, remaining at or below that point at both stations during the rest of the month. The highest stages for the month prevailed, as usual, in the Juniata; the stage at Huntingdon averaged 2.8 feet, and at Mifflin, 1.6 foot.

Owing to the extremely dry weather of the first and part of the second decade of the month, the James River continued at an unusually low stage, the readings being below the zero of the gauge. During this time the falls of the river at this point could be crossed without wetting the feet. During the last decade rains were abundant and long continued, and, under their influence, the river rose slowly to a maximum of 1.0 foot. Under ordinary circumstances the amount of rainfall which occurred over the basin would have produced a freshet, but the ground being very dry and the rain falling steadily, the greater quantity of it was absorbed before entering the stream.

The stages of the rivers throughout North Carolina continued unusually low during the month of October. During the first decade even lower gauge readings were recorded than during September. A stage of —0.1 foot was reached at Clarksville on the Dan, and 0.2 foot at Fayetteville on Cape Fear. The drought was finally broken by copious rains during the last decade, but the rainfall had remarkably little effect on the rivers, causing a rise of barely two feet in the larger streams, which continued much below the average stage at the end of the month. The first boat, since September 27, passed from Wilmington to Fayetteville on October 26. Salt water was reported farther upstream than usual, reaching, for example, to Vanceboro, a village 24 miles above Newbern.

The river basins of South Carolina were entirely rainless from September 23 to October 10, and, in consequence, the streams receded to

exceptionally low stages. Navigation on the Wateree, the lower Pedee, the Lynch, the Little Pedee, the Black, and the Santee was suspended from the 1st to the 13th, and from the 28th to the 31st. The water was too low in the Congaree for steamers to reach Granby Falls, the head of navigation. There was no traffic on the upper Pedee during the month, although the stream at Cheraw rose and declined rapidly on the 14th and 15th, respectively. The Lumber, at Fairbluff, was below the zero of gauge from the 1st to the 24th, reaching its lowest stage, -0.8 foot, on the 11th to 13th, and falling below the stage of October 20 and 21, 1895, by 0.5 foot. The Santee, at St. Stephens, was below the zero of gauge from the 5th to 13th, the lowest reading recorded being -1.3 foot, or 0.1 foot higher than the readings of September 20-22.

The great lack of rainfall caused Winyah Bay and the extreme lower portions of the Pedee, Waccamaw, and Black rivers, for several miles upstream, to become brackish from the 1st to the 13th. The rice planters were unable to use any of the river water during that period on their June, or late, rice, for fear of blasting it. Many sawmills, located on upper Winyah Bay and the lower Pedee and Waccamaw rivers, were compelled to suspend operations on account of the brackishness of the water, which ruins boilers. This encroachment of salt water so far inland has not occurred in seven years. The mill men have begun digging wells, varying in depth from 200 to 500 feet, and, if successful, will be entirely independent of river water. It is stated, upon good authority, that the limit of salt water in the streams this year exceeds, by some 4 miles, that of the past thirty-five years. The suspension of navigation on most of the streams for nearly three weeks crippled steamboat interests to a great extent. It is estimated that the loss foots up to \$90,000. For the month of September cotton receipts, by way of the rivers, were but little over 11,200 bales, or 60 per cent of what they usually are, and during October the amount was slightly less. Much cotton was transported long distances to railroad stations, since it could not be sent by water. Conditions were somewhat modified by moderate showers over the northern section of this State and the central portion of North Carolina on the 10th to 12th, which caused a 10-foot rise at Camden and a 11-foot rise at Cheraw on the 14th, and afforded steamboat water on the Santee, the Wateree, the lower Black, the lower Pedee, the Lynch, and the Little Pedee rivers from the 14th to the 27th. The Edisto remained at a fair steamboat stage throughout the month, but, owing to numerous snags, there was little navigation upon it. Navigation up the Waccamaw, from Winyah Bay to Conway, was uninterrupted, and traffic was somewhat increased by the heavy shipments of cotton and naval stores.

The rainfall for the month in the Savannah watershed, while of an average amount, was not sufficient for full navigation. There was practically no rain during the first decade, which necessitated a tie-up of the river boats in use at this season. After the 11th there were two small rises, one occurring in the second decade and the other in the third, which contributed toward a partial restoration of river traffic. Taking it all in all the extreme shallowness of the river made navigation for October decidedly unprofitable.

The protracted drought was temporarily broken by one or two good rains, but most of the water which fell was taken up by the soil, so that little or no effect was felt in the Georgia streams. Low water continues at all stations, and the rivers are below the boating stage. At Columbus, Ga., several steamers are stranded, and can not move until lifted by a rise in the river.

Mobile River and branches. (Reported by F. P. Chaffee, Montgomery, Ala., and W. M. Dudley, Mobile, Ala.)—The rainfall during the month was light and widely scattered, and insufficient to cause any material rise in the Alabama River and its tributaries during the entire month, and the very low waters which prevailed caused an entire suspension of river traffic. In the larger streams the water was below the gauge zeros all the month, and at Selma, Ala., it remained 2 feet below zero from the 1st to the 19th, inclusive.

The beginning of October found the Tombigbee River and its tributaries with little water in them, all places reporting the stage below the zero of gauge. Very little precipitation occurred during the month. A heavy shower fell at Columbus, Miss., on the 12th, but made no material change in the river. The low stage of water continued to the close of the month. Navigation was seriously retarded by the severe quarantine regulations established by the different counties. During the latter part of the month the restrictions were modified, but, owing to the low stage of the rivers, boats were unable to proceed more than 60 to 65 miles from Mobile.

Ohio River and branches. (Reported by F. Ridgway, Pittsburg, Pa.; H. L. Ball, Parkersburg, W. Va.; S. S. Bassler, Cincinnati, Ohio; F. Burke, Louisville, Ky.; P. H. Smyth, Cairo, Ill.; L. M. Pindell, Chattanooga, Tenn.; and H. C. Bate, Nashville, Tenn.)—Navigation on the upper Ohio and the rivers of West Virginia was suspended throughout the month. The Ohio and the two Kanawhas held such low stages that ferryboats at some points found it difficult to make crossings. In many parts of West Virginia the smaller rivers were nearly dry, and some actually ceased running. The stage at Parkersburg ranged from 2.6 feet on the 1st to 0.9 foot during the closing days of the month. Curiously enough, a traction engine was reported to have forded the Ohio near Ravenswood without having its fire extinguished, the river being so low.

At Cincinnati there was practically no change in the river situation during the month of October, very low water with slight and unimportant variations prevailing the entire month. A slight rise in the Great Kanawha on the 13th and 14th afforded an opportunity to take empty coal barges to the mines. The highest stage at Cincinnati in October was 4.2 feet on the 20th, the lowest 3.0 feet during the evening of the 26th. River business has been practically at a standstill during the month.

At Louisville the stage of water fluctuated but very little, preserving an average depth of 4 feet. This precluded navigation by all except the smaller boats. The lighter packets of the Cincinnati Mail Line continued to run throughout the month. At Evansville and Paducah the river was practically at a stand the entire month; at Evansville the stage varied only 0.6 foot during the month, while at Paducah the range was only 0.5 foot. At Cairo the river fell 0.1 foot per day during the first decade, but from the 10th to the 31st it was practically stationary. The long-continued low stage of the river is seriously interfering with navigation, it being possible to conduct it only in a small way. All steamers from Cairo to the upper Ohio have been abandoned. The Cairo and Paducah Packet continued running, but it was necessary to put on a light-draught steamer. Usually at this time of the year a moderate rise is looked for out of the Ohio, and rivermen are now anxiously looking forward to its expected coming.

The Tennessee River remained low during the entire month, rendering navigation impossible; on October 20 a light-draught boat tried to make a trip from Chattanooga to Kingston during the slight rise that occurred, but the trip was unsuccessful, as the boat on her return trip could not pass over the bars. The highest stage the river reached during the month, from Riverton, Ala., to Speers Ferry, Va., was 2.4 feet at Clinton, Tenn. The river was below the zero of the river gauge the entire month at Speers Ferry and Riverton; from the 1st to 18th at Florence, Ala.; and from the 7th to 20th at Knoxville, Tenn. The rainfall was slightly below the normal over the river system, but at Chattanooga it was slightly in excess.

On the Cumberland River navigation was closed all the month. The stage of the river ranged from a maximum of 0.4 at Nashville to a minimum of -0.7 foot at Burnside. The month closed with rain falling, but not enough is expected to materially affect river conditions.

Mississippi River and branches, except the Ohio. (Reported by P. F. Lyons, St. Paul, Minn.; M. J. Wright, Jr., La Crosse, Wis.; G. E. Hunt, Davenport, Iowa; F. Z. Gosewisch, Keokuk, Iowa; H. C. Frankenfield, St. Louis, Mo.; P. H. Smyth, Cairo, Ill.; S. C. Emery, Memphis, Tenn.; R. J. Hyatt, Vicksburg, Miss.; R. E. Kerkam, New Orleans, La.; L. A. Welsh, Omaha, Neb.; P. Connor, Kansas City, Mo.; F. H. Clarke, Little Rock, Ark.; J. J. O'Donnell, Fort Smith, Ark.; and C. Davis, Shreveport, La.)—There is little of consequence to be said about the rivers of Minnesota during the month of October, 1897. The wharf at St. Paul remained completely deserted, inasmuch as navigation remained suspended, although the stage of water, as indicated by the gauge, was much higher than that of any other October since 1881; it was 4.9 feet on the 1st, and gradually declined to 3.8 feet on the 31st.

At La Crosse the stage of water in the Mississippi River averaged nearly half a foot lower than during the preceding month. No packets were running during the month, but rafting, although light, was unusually good for the season. The water was highest at the beginning and ending of the month, and was lowest from the 16th to the 22d.

Except at Red Wing, Minn., where 4.51 inches of rain fell, there was a deficiency in rainfall at all stations on the upper Mississippi. At North McGregor, Iowa, 0.03 inch of rain made up the sum for the entire month. Except at St. Paul the stage remained practically stationary at all stations. The water was not high enough for the larger boats, but the smaller local packets ran to Davenport the entire month without inconvenience. Some rafting was still going on at the end of October.

At Keokuk the river fell very slowly from the 1st to the 19th, and since then has remained stationary at the lowest stage of the season, 1.2 foot. Navigation is confined to light-draught steamboats, carrying but partial loads, and boats, towing lumber and log rafts.

At St. Louis low stages continued throughout the month, with a fall of about 1 foot south of Grafton. Navigation is impossible except for boats of very light draught, and of these a few are still running on the upper Mississippi, and one between St. Louis and Peoria on the Illinois River.

The Mississippi, between St. Louis and Cairo, has been at a stand or falling slowly during the entire month. The low stage of water has compelled the laying up of the St. Louis and Tennessee River packets. All regular boats have been laid up, and navigation is being carried on only in a small way. The St. Louis and Mississippi Valley Transportation Company have tows at Point Pleasant, Mo., and Memphis, Tenn., bound for southern points, which have, on account of low water, been tied up since the latter part of September. This company has also eight barges at Cairo waiting for a rise in the river before they can be gotten out. The Anchor Line steamer *Mary Morton*, which was sunk near Chester, Ill., on October 1, is reported a total wreck.

Between Cairo and Helena there was a steady fall up to the 24th, upon which date the gauge reading at Memphis was 0.3 foot, and that low stage was maintained until the end of the month. The monthly

average stage was 4.5 feet below normal. While lower stages have occurred in former years, notably in 1894 and 1895, not for a number of years have so many casualties been reported as during the present season, most of which were caused by boats coming in contact with snags and other obstructions, where the water was shallow. Just at this season of the year traffic is generally heavier than at any other time, on account of the movement of the cotton crop, but this season, owing to the low water and the quarantine restrictions combined, river business has been light, and many of the large boats were laid up during a greater part of the month.

From Helena to Vicksburg the stage of water continued low throughout the month, falling below zero on the gauge at Helena on the 15th, at Greenville on the 13th, and at Vicksburg on the 3d. The Yazoo River was below the gauge zero at Yazoo City the entire month, and the mouth of the Yazoo is still closed to navigation by the sandbar. The low stages of water and the quarantine regulations continued to restrict river traffic, at a great loss to river interests at this time, when, usually, river business is very active in transporting cotton, cotton seed, corn, and plantation supplies generally. The bulk of the crops has been gathered, and is awaiting shipment to market.

The Mississippi, below Vicksburg, continued at a low stage the entire month, there being a general, slight, and gradual decline between Vicksburg and New Orleans from the opening to the closing days. The stage at and below New Orleans was subject to fluctuations due to change of winds, and a backing up of the waters from the Gulf. Green sea water was observed as far up as New Orleans, and salt water fish were caught along the river front. Numerous points along the rivers quarantined against New Orleans, owing to the prevalent yellow fever, and there was but little traffic on the rivers during the entire month.

The stage of water in the Missouri River above Kansas City, continued low and steady throughout the month. The entire range of gauge readings at Omaha was only 0.2 foot, the stage being the same at the close of the month as at the opening; the range at Kansas City was 0.6 foot. The unusually low water was the only interesting feature in connection with the river during the month.

The Arkansas River at Fort Smith and westward remained below a navigable stage during the month, and fell steadily at Fort Smith from 1.1 foot on the 1st to 0.6 on the 31st, this being the lowest stage since January 1, 1895. With the exception of a slight rise at Little Rock on the 11th, the lower Arkansas River declined steadily throughout the month, reaching its minimum stage of -0.7 foot at Dardanelle on the 29th, and 1.0 foot at Little Rock on the 26th. This is the lowest stage recorded at Little Rock since January 16, 1881, when the stage was 0.8 foot. Navigation was suspended between Fort Smith and Pinebluff during the entire month, and the river was so low between Pinebluff and the mouth that heavily laden boats could ascend the river only to a point 8 miles below Pinebluff, where freight had to be unloaded and transported overland.

The Red River was devoid of notable features during the month; little or no rain fell, and the readings were low throughout the length of the river. From Shreveport southward, the stages were below the gauge zeros the entire month.

Rivers on the Pacific Coast. (Reported by W. H. Hammon, San Francisco, Cal.; J. A. Barwick, Sacramento, Cal.; and B. S. Pague, Portland, Oreg.)—The rivers of California remained about stationary until the 22d, when there was a slight rise until the 25th, owing to the rains on the 21st to 23d. They then began to fall and continued falling until the end of the month, when they were at about the same stage as on the 1st. The Sacramento River at Sacramento has ranged between 10.0 and 8.3 feet. Navigation has not been obstructed.

During the month the Columbia, Willamette, Snake, and tributary rivers were at the low-water stage common at this season of the year. The river steamers on the Columbia from The Dalles westward, on the Willamette northward, on the Snake from Lewiston westward, had sufficient water for navigation, and the crops have been moved readily to tidewater.

Heights of rivers above zeros of gauges, October, 1897.

Stations.	Distance to mouth of river.	Danger line on gauge.	Highest water.		Lowest water.		Mean stage.	Monthly range.
			Height.	Date.	Height.	Date.		
<i>Mississippi River.</i>								
St. Paul, Minn.	<i>Miles</i> 1,957	<i>Feet.</i> 14	<i>Feet.</i> 4.9	1	<i>Feet.</i> 3.8	30, 31	<i>Feet.</i> 4.2	<i>Feet.</i> 1.1
Reeds Landing, Minn.	1,857	13	3.1	25-28	2.2	18, 19	2.6	0.9
La Crosse, Wis.	1,822	10	4.1	25, 29	3.2	22	3.6	0.9
North McGregor, Iowa.	1,768	18	3.4	30, 31	2.5	18, 21	2.9	0.9
Dubuque, Iowa.	1,702	15	3.3	81	2.5	20, 21	2.8	0.8
Leclaire, Iowa.	1,612	10	1.9	1-3	1.3	23-26	1.5	0.6
Davenport, Iowa.	1,596	15	2.9	1, 2	2.2	18, 19 } 25-27,	2.4	0.7
Keokuk, Iowa.	1,466	14	1.8	1, 7	1.2	19-31	1.4	0.6
Hannibal, Mo.	1,405	17	2.8	1-4	1.9	26-31	2.3	0.9
Grafton, Ill.	1,307	23	3.6	1, 2	2.8	26-31	3.1	0.8
St. Louis, Mo.	1,264	30	3.9	1, 2	2.8	22-26	3.2	1.1
Chester, Ill.	1,189	80	2.5	1, 3	1.5	23-31	1.9	1.0
Calro, Ill.	1,073	40	3.6	1	2.5	20-29	2.8	1.1
Memphis, Tenn.	843	33	1.6	1	0.2	30	0.7	1.4

Heights of rivers above zeros of gauges—Continued.

Stations.	Distance to mouth of river.	Danger-line on gauge.	Highest water.		Lowest water.		Mean stage.	Monthly range.
			Height.	Date.	Height.	Date.		
<i>Mississippi River—Cont'd</i>								
Helena, Ark.	Miles. 767.	Feet. 44	Feet. 1.2	1, 2	Feet. — 0.8	26-29	Feet. 0.0	Feet. 2.0
Arkansas City, Ark.	635	42	— 0.1	1	— 2.3	27-31	— 1.4	2.2
Greenville, Miss.	595	40	0.8	1	— 1.2	30	— 0.3	2.0
Vicksburg, Miss.	474	41	0.2	1	— 2.9	31	— 1.5	3.1
New Orleans, La.	108	16	4.5	1	2.6	25, 26	3.5	1.9
<i>Arkansas River.</i>								
Wichita, Kans.	720	10	1.1	1-5	0.8	29-31	1.0	0.3
Fort Smith, Ark.	345	23	1.1	1	0.6	27-31	0.8	0.5
Dardanelle, Ark.	250	21	— 0.1	1-3	— 0.7	29-31	— 0.5	0.6
Little Rock, Ark.	170	23	2.0	1	1.0	26-31	1.5	1.0
<i>White River.</i>								
Newport, Ark.	150	26	0.2	{ 1-10, 18-31 }	0.1	11-17	0.2	0.1
<i>Des Moines River.</i>								
Des Moines, Iowa.	150	19	3.8	18-20, 20	3.0	1-10	3.4	0.8
<i>Illinois River.</i>								
Peoria, Ill.	135	14	3.8	{ 16-18, 20-31 }	3.7	1-15, 19	3.7	0.1
<i>Missouri River.</i>								
Bismarck, N. Dak.	1,201	14	2.2	28-31	1.7	9-13	1.9	0.5
Pierre, S. Dak.	1,006	14	1.1	22, 28-31	0.6	14-18	0.9	0.5
Sioux City, Iowa.	676	19	5.6	31	4.9	6	5.0	0.7
Omaha, Nebr.	561	18	4.9	{ 1, 19-21, 31 }	4.7	{ 6-15, 26-30 }	4.8	0.2
St. Joseph, Mo.	373	10	0.6	24	— 0.2	10, 11	0.2	0.8
Kansas City, Mo.	280	21	5.2	11, 12	4.6	7	5.0	0.6
Boonville, Mo.	191	30	4.6	1	3.8	16-20	4.1	0.8
Hermann, Mo.	95	21	— 0.8	1	— 1.6	18-23	— 1.3	0.8
<i>Ohio River.</i>								
Pittsburg, Pa.	966	22	6.0	1	5.3	7, 8	5.6	0.7
Davis Island Dam, Pa.	960	25	2.1	1	1.2	12	1.5	0.9
Wheeling, W. Va.	873	36	2.1	1	0.4	28-31	7.8	1.7
Parkersburg, W. Va.	785	35	2.6	1	0.9	25, 27-31	1.3	1.7
Point Pleasant, W. Va.	708	36	2.1	16	0.9	{ 11, 14, 21-23 }	1.2	1.2
Catlettsburg, Ky.	651	50	2.6	26	0.9	1, 2	1.8	1.7
Portsmouth, Ohio	612	50	3.0	18	1.7	24	2.2	1.3
Cincinnati, Ohio	499	45	4.2	20	3.0	26	3.5	1.2
Louisville, Ky.	367	24	4.3	{ 10-14, 23-25 }	3.2	1	4.0	1.1
Evansville, Ind.	184	30	1.0	1, 16, 22	0.4	6	0.8	0.6
Paducah, Ky.	47	40	0.1	1, 2	0.3	8-11	— 0.1	0.4
<i>Alleghany River.</i>								
Warren, Pa.	177	7	0.0	1-31	0.0	1-31	0.0	0.0
Oil City, Pa.	123	13	0.3	1-3	0.0	17-31	0.1	0.3
Parkers Landing, Pa.	73	30	0.2	1-3	0.4	30, 31	— 0.1	0.6
Freeport, Pa.	26	30	1.0	1	0.4	19-31	0.5	0.6
<i>Cornwall River.</i>								
Johnstown, Pa.	64	7	1.4	1	0.4	26-30	0.7	1.0
<i>Red Bank Creek.</i>								
Brookville, Pa.	35	8	— 0.2	1-31	— 0.2	1-31	0.2	0.0
<i>Beaver River.</i>								
Ellwood Junction, Pa.	10	14	— 0.5	1, 2	— 1.3	28-31	— 0.9	0.8
<i>Umbagog River.</i>								
Burnside, Ky.	434	50	— 0.4	17-20	— 1.0	11	— 0.7	0.6
Carthage, Tenn.	257	30	0.3	13, 14	0.0	30, 31	0.1	0.3
Nashville, Tenn.	175	40	0.4	1, 2, 17	0.0	{ 25-27, 30, 31 }	0.2	0.4
<i>Great Kanawha River.</i>								
Charleston, W. Va.	61	30	7.2	15	5.7	18	6.3	1.5
<i>New River.</i>								
Hinton, W. Va.	95	14	2.3	14	0.8	7-12	1.2	1.5
<i>Licking River.</i>								
Falmouth, Ky.	30	25	0.4	1, 2	0.0	17-20	0.2	0.4
<i>Miami River.</i>								
Dayton, Ohio	69	18	1.0	13, 14, 24	0.5	8-11	0.7	0.5
<i>Monongahela River.</i>								
Weston, W. Va.	161	18	— 2.2	2-15	— 2.5	18-31	— 2.4	0.3
Fairmont, W. Va.	119	25	— 0.6	1-9	— 0.7	10-31	— 0.7	0.1
Greensboro, Pa.	81	18	5.8	1-5	4.3	{ 27, 28, 30, 31 }	5.1	1.5
Lock No. 4, Pa.	40	28	7.4	3, 4	4.7	30, 31	6.0	2.7
<i>Cheat River.</i>								
Rowlesburg, W. Va.	36	14	0.1	1	— 1.2	25	— 0.6	1.3
<i>Youghiogheny River.</i>								
Confluence, Pa.	59	10	0.4	1	— 0.1	20-31	0.0	0.5
West Newton, Pa.	15	23	0.2	1-5	— 0.2	22-31	0.0	0.4
<i>Muskingum River.</i>								
Zanesville, Ohio	70	20	5.3	{ 16, 18, 23, 26, 28 }	4.6	10, 11	5.0	0.7
<i>Tennessee River.</i>								
Knoxville, Tenn.	614	29	0.2	1	— 0.3	14-19	0.0	0.5
Kingston, Tenn.	534	25	0.5	23	0.0	{ 1-19, 26-31 }	0.1	0.5
Chattanooga, Tenn.	430	33	2.0	21	0.4	8-10	1.0	1.6
Bridgeport, Ala.	390	24	0.8	22	— 0.2	9-12	0.2	1.0
Florence, Ala.	220	16	0.3	25, 26	— 0.5	11	— 0.1	0.8
Johnsonville, Tenn.	94	21	0.7	28	— 0.3	6-20	0.0	1.0
<i>Clinch River.</i>								
Speers Ferry, Va.	156	30	— 0.6	{ 3, 6, 7, 12, 13, 19, 20, 23, 25-27, 29-31 }	— 0.8	10, 15-17	— 0.7	0.2
<i>Wabash River.</i>								
Clinton, Tenn.	46	25	2.4	25-27	1.8	3, 11	2.1	0.6
<i>Red River.</i>								
Mount Carmel, Ill.	50	15	0.7	1-3	0.5	21-31	0.6	0.2
<i>Red River.</i>								
Arthur City, Tex.	688	27	4.1	1	2.4	28-31	2.9	1.7
Fulton, Ark.	565	28	3.7	2	1.4	26-30	2.0	2.3
Shreveport, La.	449	29	— 0.2	7, 8	— 1.6	28-31	— 1.0	1.4
Alexandria, La.	139	33	1.9	12, 13	— 2.8	26-28	— 2.4	0.9
<i>Atchafalaya Bayou.</i>								
Melville, La.	100*	31	2.7	2-4	1.6	26-30	2.3	1.1

Heights of rivers above zeros of gauges—Continued.

Stations.	Distance to mouth of river.	Danger line on gauge.	Highest water.		Lowest water.		Mean stage.	Monthly range.
			Height.	Date.	Height.	Date.		
<i>Ouachita River.</i>	<i>Miles.</i>	<i>Feet.</i>	<i>Feet.</i>		<i>Feet.</i>		<i>Feet.</i>	<i>Feet.</i>
Camden, Ark.....	340	39	2.6	11-17	2.4	19-30	2.5	0.2
Monroe, La.....	100	40	0.0	1-31	0.0	1-31	0.0	0.0
<i>Yazoo River.</i>								
Yazoo City, Miss.....	80	25	-2.4	12-14	-2.7	2-4, 31	-2.6	0.3
<i>Chattahoochee River.</i>								
Columbus, Ga.....	140	20	0.1	24-27	-1.5	10-12, 16	-0.8	1.6
<i>Flint River.</i>								
Albany, Ga.....	80	30	1.7	4	0.8	12, 28	1.2	0.9
<i>Cape Fear River.</i>								
Fayetteville, N. C.....	100	38	2.2	27	0.2	8, 9	0.9	2.0
<i>Columbia River.</i>								
Umatilla, Oreg.....	270	25	2.8	23, 24	2.1	31	2.6	0.7
The Dalles, Oreg.....	166	40	4.9	9	2.8	31	4.0	2.1
<i>Willamette River.</i>								
Albany, Oreg.....	99	30	2.5	26	1.0	1-19	1.2	1.5
Portland, Oreg.....	10	15	3.2	29	0.4	21	2.0	2.8
<i>Edisto River.</i>								
Edisto, S. C.....	75	6	4.8	1, 2	2.6	13, 13	3.6	2.2
<i>James River.</i>								
Lynchburg, Va.....	257	18	0.4	24	-0.2	1-11	0.0	0.6
Richmond, Va.....	110	12	1.0	27	-0.3	4-14	0.0	1.3
<i>Alabama River.</i>								
Montgomery, Ala.....	265	35	-0.2	19	-1.5	6-16	-1.2	1.3
Selma, Ala.....	212	35	-0.8	21	-2.0	1-19	-1.8	1.2
<i>Cocoa River.</i>								
Gadsden, Ala.....	144	18	-0.3	21-26	-0.8	2-11	-0.6	0.5
<i>Tombigbee River.</i>								
Columbus, Miss.....	225	33	-3.2	12	-3.7	28-30	-3.6	0.5
Demopolis, Ala.....	155	35	-3.4	1-6	-2.6	13-31	-2.5	0.2
<i>Black Warrior River.</i>								
Tuscaloosa, Ala.....	90	38	-1.6	1, 23-31	-1.9	6, 9-21	-1.8	0.3
<i>Pedee River.</i>								
Cheraw, S. C.....	145	27	11.2	14	0.3	12	1.5	10.9

Heights of rivers above zeros of gauges—Continued.

Stations.	Distance to mouth of river.	Danger line on gauge.	Highest water.		Lowest water.		Mean stage.	Monthly range.
			Height.	Date.	Height.	Date.		
<i>Black River.</i>	<i>Miles.</i>	<i>Feet.</i>	<i>Feet.</i>		<i>Feet.</i>		<i>Feet.</i>	<i>Feet.</i>
Kingstree, S. C.....	60	12	3.6	31	1.0	15-18	2.2	2.6
<i>Lumber River.</i>								
Fairbluff, N. C.....	10	6	0.5	31	-0.8	11-13	-0.2	1.3
<i>Lynch Creek.</i>								
Effingham, S. C.....	35	12	3.7	26	2.1	7-13	2.6	1.6
<i>Potomac River.</i>								
Harpers Ferry, W. Va....	170	16	0.4	26-28	0.0	4-24	0.1	0.4
<i>Roanoke River.</i>								
Clarksburg, Va.....	155	12	0.3	20, 29	-0.1	5-11	0.1	0.4
<i>Sacramento River.</i>								
Redbluff, Cal.....	241	23	1.2	23	0.0	1, 10, 11	0.4	1.2
Sacramento, Cal.....	70	25	10.0	25, 26	8.3	1-3	8.8	1.7
<i>Santa River.</i>								
St. Stephens, S. C.....	50	12	6.5	18	-1.3	9, 10 1-12	1.8	7.8
<i>Oconee River.</i>								
Columbia, S. C.....	37	15	3.5	14	1.5	16-20 24-31	1.7	2.0
<i>Watauga River.</i>								
Camden, S. C.....	45	24	12.4	14	1.6	10	3.7	10.8
<i>Savannah River.</i>								
Augusta, Ga.....	130	32	8.5	14	3.9	11	5.5	4.6
<i>Susquehanna River.</i>								
Wilkesbarre, Pa.....	178	14	0.0	1-31	0.0	1-31	0.0	0.0
Harrisburg, Pa.....	70	17	1.8	1	0.5	21	0.9	1.2
<i>Juniata River.</i>								
Huntingdon, Pa.....	80	24	3.0	26	2.8	1-25 28-31	2.8	0.2
<i>W. Br. of Susquehanna.</i>								
Williamsport, Pa.....	35	20	0.9	1, 2	0.3	9-12 18-20	0.5	0.6
<i>Waccamaw River.</i>								
Conway, S. C.....	40	7	2.7	21	1.1	14, 15	1.9	1.6

*Distance to Gulf of Mexico.

SPECIAL CONTRIBUTIONS.

WINDS AND CLOUDS.

By Professor BRILLOUIN of the École Normale Supérieure, Paris.

[Translated from the *Annales de Chimie et de Physique*, October, 1897, pp. 145-153, and *Ciel et Terre*, October 16, 1897, pp. 393-399. Communicated as a summary of a more elaborate memoir that will be published in the *Annals* for 1898 of the Central Meteorological Bureau of France.—C. A.]

After having for a long time devoted their efforts to the study of atmospheric pressure, meteorologists have now turned their attention to the clouds; they photograph them and endeavor above all to record the heights of the various types. The description of the forms and their relations to meteorology in general has made but very little progress because in most of the recent treatises the chapters relating to the clouds have been restricted to the enumeration of the different types adopted by the international conferences without any further indications.¹ Some treatises are even more positive, and formally declare that up to this time it has not been possible to make any use of the aspect of the sky for forecasting the weather;² this is probably true of the central offices of the weather services on account of the insufficiency of the short telegraphic dispatches, but is quite the reverse when we consider the experience of an isolated observer.³ The appearance of the sky suffices to show what

¹ Lancaster remarks that this opinion, which was true ten years ago, is no longer so to-day. The investigations into the forms of clouds and the relations of these to the various atmospheric conditions are now carried on everywhere with great activity, and very important works on this subject have been recently published. Among the most recent and most interesting we mention the beautiful memoir of Mr. H. Helm Clayton, "Discussion of the Cloud Observations made at the Blue Hill Observatory," which forms the fourth part of Volume XXX of the *Annals of the Astronomical Observatory of Harvard College*, Cambridge, Mass. This memoir is accompanied by numerous plates, and contains more than 200 quarto pages.

² Van Bebber. *Handbuch der ausübenden Witterungskunde*, 2 vols., 1886. Die Witterungsvorhersage, 1 vol., 1891, pp. 50.

³ The upper and lower clouds were elaborately observed and telegraphed for the use of the daily weather bulletin of the Cincinnati Observatory, beginning with September, 1869, and have also been telegraphed and shown on the tridaily charts of the Signal Service and Weather Bureau ever since July, 1871. They have often proved of great importance in making up the weather forecasts.—C. A.

is passing at a distance of at least 100 or 200 kilometers from any station, but the experience acquired is personal because it is synthetical. This is affirmed even by those who have bestowed the most labor on this subject, e. g., Clement Ley¹ from a narrow point of view; Abercromby² with more independence of thought. It appears then that theory alone should be capable of defining absolutely consistent types, and of analyzing and describing all their characteristics. Unfortunately, until within recent years, theory has dealt only with two kinds of action capable of producing condensation,³ viz, the expansion to which we owe the cumulus clouds, and the cooling by radiation which produces the stratus clouds; these two forms which are characteristic of permanent conditions are, therefore, useless, or nearly so, for forecasting.

The transient forms which correspond to the changes of weather are due to the mixtures of air from contiguous regions, one of which is calm and the other is in movement; but the theory of these clouds due to mixture has hitherto been unapproachable. At first, the physical theory of condensation by mixture was so complex, from an analytical

¹ Modern Meteorology (1878). Fourth Conference. Clouds and Weather Signs, by Cl. Ley, pp. 102-136. Aids to the Study and Forecast of the Weather, 1880. Cloudland, 1891, 1 vol.

Unfortunately Ley ascribes everything to the "cyclones" of the temperate regions. A glance at his illustrations will show that we have to do, not with the coordination around a center, but with two contiguous currents which interfere with each other and are equivalent to the sketch given farther on. Ley's diagram is simply reproduced by Sprung in his *Lehrbuch der Meteorologie*, 1885.

² Weather: A Popular Exposition of the Nature of Weather Changes from Day to Day, by the Hon. Ralph Abercromby (3d edition), 1892. 1 vol., London. Tropical and Extratropical Cyclones (Proc. of the Royal Society of London, Vol. XLIII, 1887, pp. 1-30). This article was written on his return from a meteorological journey around the world. In the two pages of "Conclusions" the author admirably describes the difference between the storms of our latitudes and those of the tropics; the last phrase, which gives more importance to the analogies than to the differences, is the only part that is ordinarily quoted.

³ It should perhaps be said that the older theory of mixtures was equally prominent until Espy and Hann forced it into the background. (See Hann's *Memoirs*, translated by the Editor, in the *Ann. Rep. Smithsonian Inst.*, 1877.)—C. A.